1.0
1.1
1.25
1.4
1.6
2.5
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

DOCUMENT RESUME

ED 148 450 JC 780 074

AUTHOR Ozsogomonyan, Ardas; Clinkscales, Kyle
TITLE The Chemistry Preparatory Course in Community Colleges: A Case Study.
PUB DATE [77]
NOTE 27p.

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Academic Achievement; Academically Handicapped; *Chemistry Instruction; Community Colleges; *Course Evaluation; Enrollment Rate; *Junior Colleges; Learning Readiness; *Remedial Courses; Student Characteristics; Transfer Students; Underachievers

ABSTRACT

A four year study was made of the effectiveness of a chemistry preparatory course (Chemistry 51) on students' success in general chemistry (Chemistry 1A-1B) in the three colleges of the San Mateo County Community College District (California). Data indicated: (1) approximately 60% of the students enrolled in Chemistry 51 completed the course, and of these, approximately 25% subsequently enrolled in Chemistry 1A and approximately 18% enrolled in Chemistry 1B; (2) Chemistry 51 grades were reliable indicators of Chemistry 1A performance; (3) Chemistry 51 graduates appeared to perform equally with those students enrolled directly into Chemistry 1A and 1B; (4) repeating students constituted 7.6% of Chemistry 51 enrollment, and over half of these repeaters withdrew from the course; (5) 96 students transferred from one college to another while taking the three course sequence, and appeared to maintain their level of performance. These courses were taught in the traditional lecture-discussion mode, with laboratory work included. The majority of the students enrolled in Chemistry 51 had no chemistry background and were inadequately prepared in mathematics and communication skills. (LH)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED148450

THE CHEMISTRY PREPARATORY COURSE IN COMMUNITY COLLEGES: A CASE STUDY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Ardas Ozsogomonyan

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

Ardas Ozsogomonyan
Skyline College
San Bruno, CA 94066

Kyle Clinkscales
College of San Mateo
San Mateo, CA 94402

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

JC 780 074

A detailed examination of college catalogs reveals that nearly all California community colleges require completion of a chemistry course as a prerequisite to enrolling in Chemistry 1A, the freshman college chemistry course offered to science and engineering majors. Typically, the catalogs state: "Prerequisite: Chemistry 51 with a grade of C or better or high school chemistry with a grade of C or better ..." (1). In some colleges, high school chemistry is not mentioned. Instead, the following is stated: "Prerequisite: A qualifying score on the chemistry placement test or Chemistry 51 with a grade of C or higher ..." (2). This study was undertaken to assess the effectiveness of a chemistry preparatory course (Chemistry 51) on students' success in general chemistry, Chemistry 1A-1B in the three colleges of the San Mateo County Community College District.[1] Specifically, data were analyzed to yield answers to the following questions:

(1) What percentage of students enrolled in Chem 51 complete the course and what percentage of those who complete Chem 51 continue with Chem 1A and 1B?

(2) What is the correlation among the grades in Chem 51 and Chem 1A?

(3) How do the students who complete Chem 51 perform in Chem 1A and 1B as compared to those who start directly with Chem 1A?

(4) What percentage of students repeat Chem 51 and what are the grades on the second occasion?

(5) How many students complete the Chem 51, 1A, and 1B sequence by transferring from one college to another in the district and how do these students perform at the second college?

SIGNIFICANCE OF THIS STUDY

Community colleges, the fastest growing institutions of the American higher education, admit all students eighteen years of age or older. A high school diploma is not a prerequisite. Consequently a significant function of the community colleges is to offer courses preparatory to college-level curricula. Many basic skills courses in sciences, mathematics, and English are available (a) for those who never completed a prerequisite high school course in those areas (the unprepared students) and (b) for those who completed such courses but with poor retention (the underprepared students).

The rationale for providing preparatory courses for college students is based on the assumption that it is possible to teach within a reasonably short period of time, the necessary cognitive skills not learned in high school. To this end, community colleges allocate

resources in the form of teacher time, learning centers, media centers, and tutoring services.

Studies on the effectiveness of preparatory courses in chemistry are very few. Two studies have been undertaken by community college instructors. Coley investigated ten independent variables as possible predictors of success in Chem 1A (3). His findings indicated that grades in Chem 31 (the preparatory course) were the best predictors of success in Chem 1A at Chabot College. Mooney investigated the factors contributing to student success in the preparatory course, Chem 3, at El Camino College (4). As part of his study, Mooney also examined the success rate of Chem 3 students in the subsequent course, Chem 1A. His findings indicated that about 53 percent of Chem 3 students who had completed this course with a grade of C or better completed Chem 1A with a grade of C or better. Reports from four-year institutions on the effectiveness of chemistry preparatory courses for underprepared students have also appeared (5, 6, 7).

The first four issues examined in this study are of interest to chemistry instructors in all community colleges, whereas the last issue is of importance primarily to those who teach in a multicollege district. In a multicollege district such as ours (see note 1), students do transfer from one college to another. Clearly, these students would be at a serious disadvantage if the topics covered in sequential courses (e.g., Chem 51-1A-1B) were not standardized in the district colleges. For example, whether homogeneous and heterogeneous equilibria along with kinetics and introductory thermodynamics are covered in the first part

or the second part of the freshman chemistry course is an important issue to agree upon in any multicollege district. In our district, such an agreement was reached several years ago, and the above topics are covered during the second part (Chem 1B) of the course. Performance of transfer students as compared to those who take the year course within the same college would indicate the relative effectiveness with which one college prepares students for another college within the same district.

This study does not question the necessity of offering courses preparatory to college-level courses in a college. Such courses are necessary in view of the open-door policy practiced by community colleges and also some four-year institutions (8). Clearly, non-selectively admitting students to a college on one hand and not providing them with the opportunity to learn the cognitive skills prerequisite to college-level work on the other is an undesirable modus operandi (9).

The present study examines in detail students' progress from a preparatory chemistry course on to freshman chemistry in a community college. The results are expected to be useful in making decisions about various aspects of preparatory courses: class size and instructional design, to name but two. Instructional design refers, for example, to the decision to offer a course in the traditional lecture-discussion style or in an individualized format or a combination of both. Results of this study are likely to have high external validity (generalizability to other community colleges) because the variety of students and programs found in these three colleges examined are likely to be representative of most such colleges.

RESEARCH METHODOLOGY

A period of four years starting with spring 1972 and ending with spring 1976 was examined. The following groups of students constituted the population under study: (a) students enrolled in Chem 51 from spring 1972 through spring 1975; (b) students enrolled in Chem 1A from fall 1972 through fall 1975; (c) students enrolled in Chem 1B from spring 1973 through spring 1976. The data needed were available on roll sheets for each course and for each section. These roll sheets are permanently kept in the registrars' offices and contain students' names, social security numbers, midterm grades, and final grades.

Within each course, each section was identified with the following information: the semester in which the course was taught (fall, spring, or summer), the course number (Chem 51, 1A, or 1B), the instructor, and the time of day (day or evening class). Students in each course were identified by their social security numbers and by the grades they received. The grades and their point values used are: A(4.0), B(3.0), C(2.0), D(1.0), F(0.0), I(incomplete, does not count), and W (withdrawal, does not count).

The computer programs written to analyze the data identified each student uniquely by his or her social security number and traced the path of that student from Chem 51 to Chem 1A and then to Chem 1B. The programs also analyzed the data backwards, starting with students in Chem 1A and tracing back to Chem 51 and forward to Chem 1B as well as starting with Chem 1B and tracing back to Chem 1A and Chem 51. The statistical significance of various distributions was evaluated using chi-square[2] (χ^2) statistics (10, 11).

STUDENT AND COURSE CHARACTERISTICS

Students in Chem 51 constitute a heterogeneous group. Many have no chemistry background and also have an inadequate preparation in mathematics and in communications skills. However, some students enrolled in Chem 51 did complete a high school chemistry course, presumably with poor retention since they opted to enroll in Chem 51, and also have adequate mathematics preparation (two or three years of high school mathematics). The exact proportions of each group in the course are unknown but occasional surveys indicate that the majority of the students fall in the first group (unprepared students). In this study no distinction is made between these two groups. In addition, we have observed that most Chem 51 students lack self-confidence in their ability to succeed in chemistry and mathematics courses. This observation is corroborated by the findings of Kotnik (8).

Chem 51 is offered every semester at all three colleges. At Skyline and Canada, the course consists of three lecture hours and one three-hour laboratory period, operated on an open lab format at Canada but not at Skyline. At CSM, students spend six hours per week with the instructor but this time is utilized flexibly, a practice made possible by assigning about 30 students per instructor per section. The topics covered in Chem 51 are nearly the same in the three colleges: review of basic algebra, the metric system, atomic and molecular structure, bonding, stoichiometry, gases, and solutions. In the laboratory, activities include but are not limited to the following: learning various motor skills (weighing, bending glass, using a crucible, inserting glass tubing through a rubber stopper, etc.); measuring various properties

(temperature, volume, etc.); observing various chemical phenomena, describing them and making inferences. Much laboratory time is also spent on reviewing chemical principles and problem solving with special emphasis on stoichiometry. The course does not aim at fulfilling several functions. For example, it is not the first semester of a year course offered to nursing majors. It is specifically designed to prepare students for Chem 1A. Students who do complete Chem 51 but do not continue with Chem 1A receive credit toward graduation[3] by virtue of having completed a science course with laboratory.

RESULTS

Chemistry 51 graduates constitute about 25% of the total enrollment in Chem 1A and about 18% of the total enrollment in Chem 1B. These percentages are derived by including all[4] Chem 51 students who enrolled in Chem 1A and 1B.

Chemistry 51 grade distributions in the three colleges are shown in Table 1. Also shown in Table 1 are the number of classes examined, average class size, and the grade point average (GPA) at each college. Table 2 shows the actual numbers of students who completed Chem 51 with A, B, or C and enrolled in Chem 1A and Chem 1B. This table also shows the GPA's. Table 3 summarizes the information from Table 1 and Table 2 and indicates the overall yield of Chem 51 students who completed Chem 1A and 1B.

Table 4 shows the comparative enrollment figures of Chem 51 students and direct[5] students in Chem 1A and 1B. Discrepancies between Table 3 and Table 4 can be accounted for by considering students repeating the courses.

	Skyline		CSM		Canada	
	N*	%	N*	%	N*	%
A	49	10	113	11	30	11
B	86	17	176	16	40	14
C	115	23	276	25	92	32
D	22	4	72	6	21	7
F	18	4	19	2	1	1
W	200	41	427	39	101	35
I	3	1	7	1	none	none
Total	493	100%	1096	100%	285	100%
Number of classes	13		35		7	
Avg. class size	37.9		31.3		40.7	
GPA	2.4		2.5		2.4	

Table 1**

Grade Distribution in Chem 51
(This table includes all repeaters)

*This column indicates the actual numbers of students receiving a particular grade.

**Day, evening, and summer classes during the period spring 1972 to spring 1975 are included in this table.

"A" Grades in Chem 5I Followed in Each College

	P	Q		R			T		U		
	N (totals)	En-rolled in Chem 1A	% of P	Com-pleted* Chem 1A	% of Q	GPA in Chem 1A	En-rolled in Chem 1B	% of R	Com-pleted* Chem 1B	% of T	GPA in Chem 1B
Skyline	49	21	43	17	81	3.2	11	65	10	91	3.2
CSM	119	86	72	77	90	3.2	56	73	51	91	3.0
Canada	30	23	77	20	87	3.5	9	45	7	78	4.0
Overall	198	130	66	114	88	3.3	76	67	68	89	3.2

"B" Grades in Chem 5I Followed in Each College

Skyline	86	58	67	38	66	2.6	32	84	24	75	3.0
CSM	176	128	73	95	74	2.5	56	59	40	71	2.5
Canada	40	31	78	23	74	2.6	15	65	11	73	2.5
Overall	302	217	72	156	72	2.6	103	66	75	73	2.7

"C" Grades in Chem 5I Followed in Each College

Skyline	115	53	46	15	28	2.3	14	93	7	50	2.4
CSM	276	149	54	103	69	1.8	46	45	27	59	2.2
Canada	92	56	61	38	68	2.3	17	45	12	71	2.1
Overall	483	258	53	156	60	2.0	77	49	46	60	2.3

Table 2**

Enrollment and Achievement of Chem 5I Students in Chem 1A and Chem 1B

*Completed with a grade of A, B, or C. Students who completed Chem 5I with a grade of D, F, or W and who enrolled in Chem 1A are not included.

**Day, evening, and summer Chem 5I classes during the period spring 1972 to spring 1975 are included in this table. Letters above the columns are for the purpose of identifying those columns. The letter N in Column P indicates numbers of students.

	G	H		J		K		L		M	
	N total enrolled in Chem 5I	N total completed* Chem 5I	% of G	N total enrolled in Chem 1A	% of H	N total completed* Chem 1A	% of J	N total enrolled in Chem 1B	% of K	N total completed* Chem 1B	% of L
Skyline	493	294	60	132	45	70	53	57	81	41	72
Canada	285	184	65	110	60	81	74	41	51	30	73
CSM	1096	668	61	363	54	275	76	158	57	118	74

Overall yield: Chem 5I started → Chem 1A completed* → Chem 1B completed*

Skyline 493 → 70 (14% of 493) → 41 (8% of 493)

Canada 285 → 81 (28% of 285) → 30 (11% of 285)

CSM 1096 → 275 (25% of 1096) → 118 (11% of 1096)

Table 3**

Percentages of Chem 5I Students Enrolled in Chem 1A and Chem 1B

*Completed with a grade of A, B, or C.

**Day, evening, and summer Chem 5I classes during the period spring 1972 to spring 1975 are included in this table. Letters above the columns are for the purpose of identifying those columns. The letter N indicates number of students.

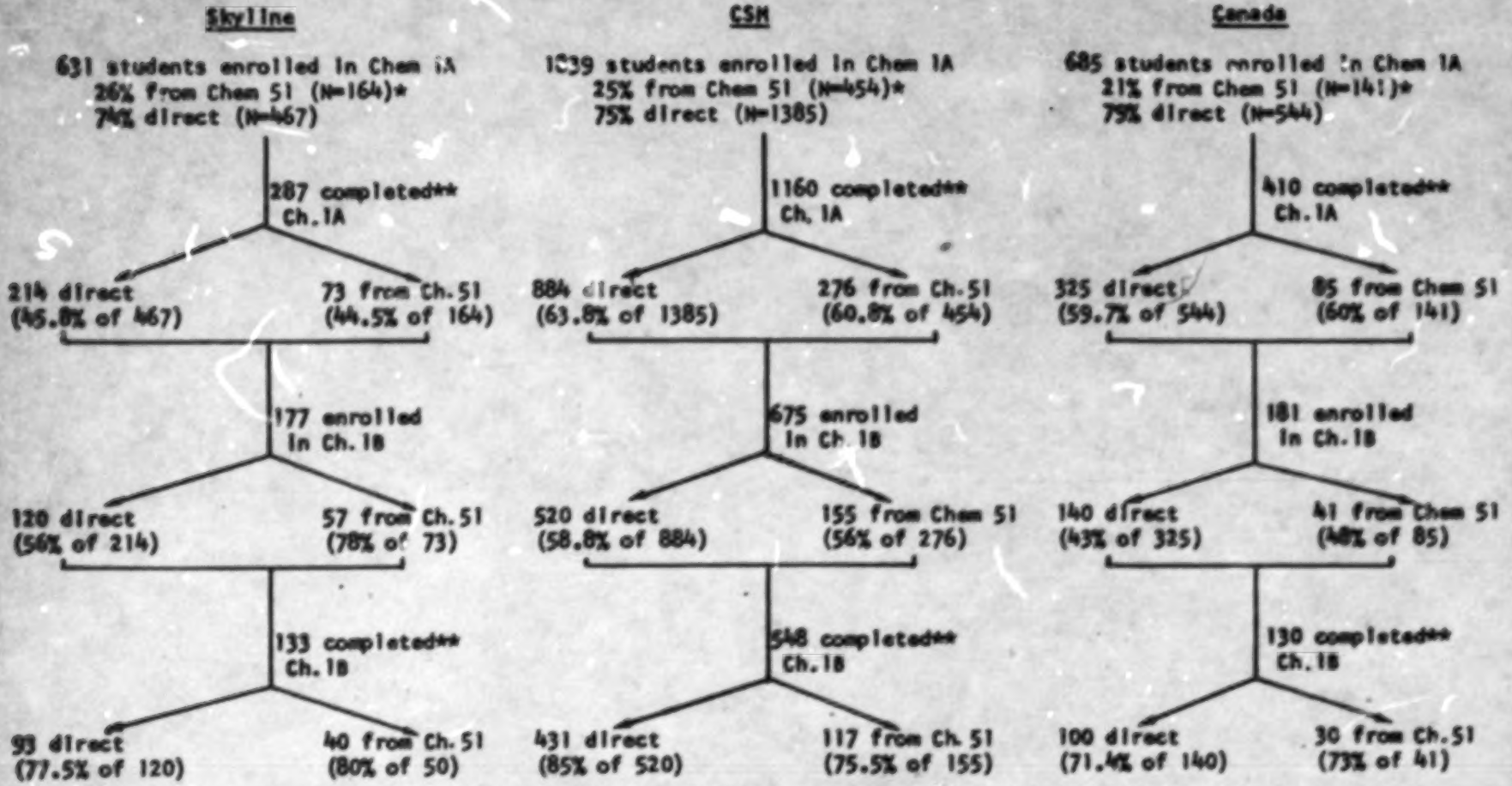
Skyline
631 students enrolled in Chem 1A
26% from Chem 51 (N=164)*
74% direct (N=467)
287 completed** Ch. 1A
214 direct (45.8% of 467)
73 from Ch. 51 (44.5% of 164)
177 enrolled in Ch. 1B
120 direct (56% of 214)
57 from Ch. 51 (78% of 73)
133 completed** Ch. 1B
93 direct (77.5% of 120)
40 from Ch. 51 (80% of 50)
CSM
1039 students enrolled in Chem 1A
25% from Chem 51 (N=454)*
75% direct (N=1385)
1160 completed** Ch. 1A
884 direct (63.8% of 1385)
276 from Ch. 51 (60.8% of 454)
675 enrolled in Ch. 1B
520 direct (58.8% of 884)
155 from Chem 51 (56% of 276)
548 completed** Ch. 1B
431 direct (85% of 520)
117 from Ch. 51 (75.5% of 155)
Canada
685 students enrolled in Chem 1A
21% from Chem 51 (N=141)*
79% direct (N=544)
410 completed** Ch. 1A
325 direct (59.7% of 544)
85 from Chem 51 (60% of 141)
181 enrolled in Ch. 1B
140 direct (43% of 325)
41 from Chem 51 (48% of 85)
130 completed** Ch. 1B
100 direct (71.4% of 140)
30 from Ch. 51 (73% of 41)

Table 4

Comparative Chem 1A and 1B Enrollment Data of Chem 51 and Direct Students (see note 5)

*Includes all students (see note 4).
**Includes only those who completed with a grade of A, B, or C.

We compared the performance of the Chem 5I students and the direct students in Chem 1A and Chem 1B by comparing the following: (a) percentages of students in each group receiving A, B, C, D, F, or W in Chem 1A and Chem 1B in each college[6]; (b) percentages of students in each group completing[7] Chem 1A, enrolling in Chem 1B, and completing Chem 1B (see Table 4). We find the following:

(1) At Skyline and at Canada the differences in the percentages described in (a) and (b) above are not significant.

(2) At CSM, the grade distributions of the two groups in Chem 1B are the same. However, the grade distributions in Chem 1A differ significantly because of the W grades. Out of 473 students who received W in Chem 1A at CSM, 23% were direct and 35% were from Chem 5I. These percentages are significantly different ($\chi^2 = 14$, $p < 0.01$). Again at CSM, the percentages described in (b) above are not significantly different.

Students repeating Chem 5I constitute 7.6% of the enrollment in the course. The exact percentages are: 6.4% at Skyline, 8.5% at CSM, and 6.3% at Canada. In each college, over 90% of the repeaters had received a grade of D, F, or W as their first grade, with the W receivers constituting the overwhelming majority as shown in Table 5. This table summarizes data on repeaters' backgrounds (first grade in the course). Table 6 shows the grade distributions after students repeated Chem 5I. It will be noted that over half of these repeaters receive a grade of W.

Our study shows that, in the San Mateo County Community College District, intercollege transfers occur primarily between CSM and Skyline

Course Repeated	First Grade Received	% of Repeaters
Chem 51 at Skyline (N=37)	W	76
	D + F + W	97
Chem 51 at CSM (N=107)	W	84
	D + F + W	92
Chem 51 at Canada (N=21)	W	95
	D + F + W	100

Table 5

Backgrounds of Students Who Repeated Chem 51
(N indicates number of students)

Course Repeated	Grade Received	% A	% B	% C	% D	% F	% W	GPA	Overall GPA
Repeated Chem 51 at Skyline (N=37)*		none	21.6	21.6	5.4	5.4	46	2.1	2.3
Repeated Chem 51 at CSM (N=107)*		4.7	16	22.4	2.8	2	52.1	2.4	
Repeated Chem 51 at Canada (N=21)*		none	none	19	none	5	76	1.6	

Table 6

Grade Distribution After Repeating Chem 51
(This table shows the second grade)

*N indicates numbers of students.

and between CSM and Canada. Very few students go from Skyline to Canada and vice versa.[8] Table 7 shows the actual numbers of students who transferred during the period under study as well as their GPA's at the second college.

DISCUSSION AND CONCLUSIONS

Examination of Tables 1, 2, and 3 reveals several important facts. Table 1 shows that the percentages of students withdrawing from Chem 51 are not different in the three colleges (ca. 40%), nor are the percentages receiving A, B, or C (ca. 53%). Moreover, although the average class size is different in the three colleges, the overall GPA's are not. These results suggest that the class size does not strongly influence student performance in Chem 51 and that increasing the class size to 40 or 45 students would have no deleterious effects on students' learning the content of this course as taught in the traditional lecture-discussion-laboratory mode.

Table 2 shows that students who complete Chem 51 with a GPA of 4.0 complete Chem 1A and Chem 1B with about a B+ average (GPA's of 3.3 and 3.2, respectively); students who complete Chem 51 with a GPA of 3.0 complete Chem 1A and Chem 1B with about a B- average (GPA's of 2.6 and 2.7); and students who complete Chem 51 with a GPA of 2.0 complete Chem 1A and Chem 1B with an average slightly better than C (GPA's of 2.0 and 2.3). The correlation coefficient, r, between Chem 51 and Chem 1A grades was found to be between 0.43 and 0.50 in the three colleges. In each case, the value of r is significant ($p < 0.01$). These findings are corroborated by Cole's (3) and suggest that the Chem 51 grade is a reliable predictor of Chem 1A performance. These results also suggest

		Number of Students	GPA*
From CSM Chem 51	to Skyline Chem 1A	20	2.5
	to Canada Chem 1A	32	2.8
From CSM Chem 1A	to Skyline Chem 1B	28	2.6
	to Canada Chem 1B	24	2.2
From Skyline Chem 51	to CSM Chem 1A	24	2.3
	To Canada Chem 1A	4	--
From Skyline Chem 1A	to CSM Chem 1B	17	3.3
	to Canada Chem 1B	none	--
From Canada Chem 51	to CSM Chem 1A	5	--
	to Skyline Chem 1A	none	--
From Canada Chem 1A	to CSM Chem 1B	37	2.4
	to Skyline Chem 1B	5	--

Table 7

Intercollege Transfers

*Includes the grades A, B, C, D, and F earned at the second college. No GPA is computed if there are five students or fewer who transferred.

that Chem 51, although taught somewhat differently in the three colleges, prepares the students for Chem 1A and Chem 1B with equal adequacy. At this time, this conclusion needs to be qualified, however, because the progress of unprepared versus underprepared students enrolled in Chem 51 is not differentiated in this study. Consequently, lack of this knowledge and the progressively smaller percentages of Chem 51 students enrolling in and completing Chem 1A and Chem 1B make it difficult to ascribe unambiguously to Chem 51 the success of students in subsequent chemistry courses. Further studies are planned to elucidate this issue.

Table 3 shows that out of every 100 students who enroll in Chem 51 and complete it with a grade of C or better, a maximum of 28 and a minimum of 14 students complete Chem 1A with a grade of C or better. Unexpectedly, a number of students who received a grade of D, F, or W in Chem 51 also enrolled in Chem 1A. However, very few of these students completed Chem 1A with a grade of C or better, and are not included in Table 3 or in Table 2. At this time, we are unable to explain the variations exhibited by Chem 51 graduates in their rates of enrollment in and completion of Chem 1A in the three colleges. However, we would like to offer the speculation that the lower percentages represent the lower limit of performance and perserverance to be expected from the population under study. Exactly what happens to nearly half of the <u>eligible</u> Chem 51 graduates who do not enroll in Chem 1A (see Table 3) is not known and needs to be investigated. Some undoubtedly complete general chemistry at the four-year institutions where they transfer. Others perhaps decide to change to majors that do not require further studies in chemistry. A small percentage are nonscience majors and complete Chem 51 to satisfy the science requirement for graduation.[9]

Table 3 also shows that between 8% and 11% of students enrolled in Chem 51 complete Chem 1B with a grade of C or better. Some of the loss from Chem 1A to Chem 1B may be explained on the basis that a few majors require only one semester of general chemistry (e.g., nutrition) and some others require eight semester units of chemistry for graduation (e.g., engineering). Thus, students majoring in engineering complete Chem 1A (5 semester units) and then enroll in a one-semester organic chemistry course (3 units) instead of completing Chem 1B (5 semester units).

Examination of Table 4 shows that, at two colleges, the percentage of Chem 51 students completing Chem 1B starting from Chem 1A is larger than the percentage of direct[10] students. Specifically, these percentages are about 28% and 20% respectively at Skyline and 21% and 18% at Canada. At CSM, however, the reverse is observed and the percentages are 26% and 32%. These results are not conclusive but suggest that Chem 51 graduates who do enroll in Chem 1A and 1B are at least as persistent as the direct students.

It was mentioned above that Chem 51 grades are reliable predictors of student success in Chem 1A and 1B. It also appears that there is no significant difference in the performance of the Chem 51 graduates and direct students in Chem 1B in the individual colleges (vide infra). This result is not surprising because students from both groups enrolling in Chem 1B are likely to be equally motivated and also equally well prepared for the course by virtue of having completed Chem 1A. In each college, the GPA's of students from either group completing Chem 1B with a Chem 1A GPA of 4.0, 3.0, or 2.0 are shown below:

(1) GPA of 4.0 in Chem 1A

Over 90 percent of these students who enroll in Chem 1B (from either group) complete Chem 1B with a GPA of about 3.5.

(2) GPA of 3.0 in Chem 1A

Between 80 to 90 percent of these students who enroll in Chem 1B (from either group) complete Chem 1B with a GPA of about 2.5.

(3) GPA of 2.0 in Chem 1A

Between 60 to 70 percent of these students who enroll in Chem 1B (from either group) complete Chem 1B with a GPA of about 2.1.

Intercollege transfer students and their GPA's in the second college are shown in Table 7. In interpreting this table, it is useful to know the overall GPA's in Chem 1A and 1B at each college. These are: at Skyline GPA (Chem 1A) = 2.4 and GPA (Chem 1B) = 2.7; at CSM, GPA (Chem 1A) = 2.5 and GPA (Chem 1B) = 2.7; at Canada, GPA (Chem 1A) = 2.6 and GPA (Chem 1B) = 2.6. Comparison of these GPA's with those of the transfer students (see Table 7) shows that the differences are not significant. This result suggests that (a) instruction provided in one college adequately prepares students for the following chemistry course in another college in the district, and (b) there is merit in standardizing the content of sequential courses in a multicollege district.

SUGGESTIONS

Preparing underprepared and unprepared students for college chemistry is necessary and feasible but is an expensive and low-yield undertaking. It would be interesting to carry out a study similar to this one in a college where the preparatory course is offered on an individualized basis. Since Chem 51 is taught in the traditional lecture-discussion mode at the San Mateo County Community College District colleges, it would be useful to know the effects of a vastly different instructional delivery style on student persistence and performance in the preparatory course and in the subsequent chemistry courses. In addition, it would be very useful to have a detailed description of entry skills (cognitive skills, traits, aptitudes, and attitudes) of students enrolled in the chemistry preparatory courses. This information would be very valuable in designing instruction for these students (12, 13). Finally, it would be useful to investigate the effectiveness of various instructional strategies to produce mastery learning (14) by undertaking true educational experiments (15).

Notes

1. The three colleges of the San Mateo County Community College District are: Skyline College (day enrollment about 3,200 students), College of San Mateo (day enrollment about 7,600 students) and Canada College (day enrollment about 3,700 students). Enrollments in evening classes are about the same as day enrollments in each college. The district operates on a semester basis.
2. Chi-square is a measure of the variance that exists between a set of observed versus expected frequencies. The value of χ^2 (the magnitude depends on the degrees of freedom, df) establishes the level of probability (acceptable level is five percent or less) with which one can claim that the difference between the observed and the expected frequencies is not due to chance events.
3. Specifically, graduation from a community college with an Associate in Arts (A.A.) degree. Chem 51 is not generally transferable to four-year colleges and universities and units earned in this course cannot be counted towards graduation from these institutions.
4. Includes not only those who received a grade of A, B, or C but also those who received a grade of D, F, or W in Chem 51.
5. Direct students enrolled in Chem 1A are those who completed the chemistry prerequisite for this course (high school chemistry) with a grade of C or better and did not take Chem 51.
6. The grade distributions in Chem 1A and Chem 1B for both groups of students at each college were computed but are not included in this paper.

7. Completing the designated course with a grade of A, B, or C.

8. This result is not surprising because Skyline and Canada are located at the northern and southern parts of San Mateo County respectively, whereas CSM is in the middle, equidistant from the two colleges. CSM is about 12 miles away from either of the other two colleges.

9. See note 3, supra.

10. See note 5, supra.

UNIVERSITY OF CALIF.
LOS ANGELES

FEB 24 1978

CLEARINGHOUSE FOR
JUNIOR COLLEGES

Literature Cited

(1) Skyline College Catalog, Skyline College, San Bruno, CA 94066.

(2) College of Marin Catalog, College of Marin, Kentfield, CA 94904.

(3) Coley, N. R., J. CHEM. EDUC., 32, 613 (1973).

(4) Mooney, W., ED013603, August 1965.

(5) Pickering, M., J. CHEM. EDUC., 52, 513 (1975).

(6) Hunter, N. W., J. CHEM. EDUC., 53, 301 (1976).

(7) Pedersen, L., J. CHEM. EDUC., 53, 418 (1976).

(8) Kotnik, L. J., J. CHEM. EDUC., 51, 165 (1974).

(9) Cross, K. P., "Accent on Learning," Jossey-Bass, San Francisco, 1976.

(10) Isaac, S., and Michael, W. B., "Handbook in Research and Evaluation for Education and the Behavioral Sciences," Robert R. Knapp, San Diego, 1974.

(11) Marascuilo, L. A., "Statistical Methods for Behavioral Science Research," McGraw-Hill, New York, 1971.

(12) Gagné, R. M., and Briggs, L. J., "Principles of Instructional Design," Holt, Rinehart & Winston, San Francisco, 1974.

(13) Ozsogomonyan, A., "Three Cognitive Skills in Chemistry and Their Application to Stoichiometry," unpublished Ph.D. dissertation, University of California, Berkeley, 1977.

(14) Block, J. H. (ed), "Mastery Learning: Theory and Practice," Holt, Rinehart & Winston, New York, 1971.

(15) Campbell, D. T., and Stanley, J. C., "Experimental and Quasi-Experimental Designs for Research," Rand McNally, Chicago, 1973.